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**Hikita**

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(54) **LUBRICANT FEED MECHANISM FOR ENGINE**

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*F01M 1/08* (2006.01)

(52) **U.S. Cl.**
CPC ................ ***F01M 9/101*** (2013.01); ***F01M 9/10*** (2013.01); *F01M 1/08* (2013.01)

(58) **Field of Classification Search**
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USPC ............................... 123/90.33, 90.34, 196 R
See application file for complete search history.

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(57) **ABSTRACT**

Provided is a lubricant feed mechanism for an engine in which space above a cam cap is not used. A lubricant feed mechanism for an engine is configured to feed lubricant through a cylinder head, a camshaft, and a cam cap to a cam of a valve gear. The mechanism includes an oil feed member that is disposed in the cam cap such that an upper end thereof is set at a lower level than an upper end of the cam cap in a height-wise direction and has an oil passage configured to guide lubricant to be fed through the cam cap to the cam.

**20 Claims, 14 Drawing Sheets**

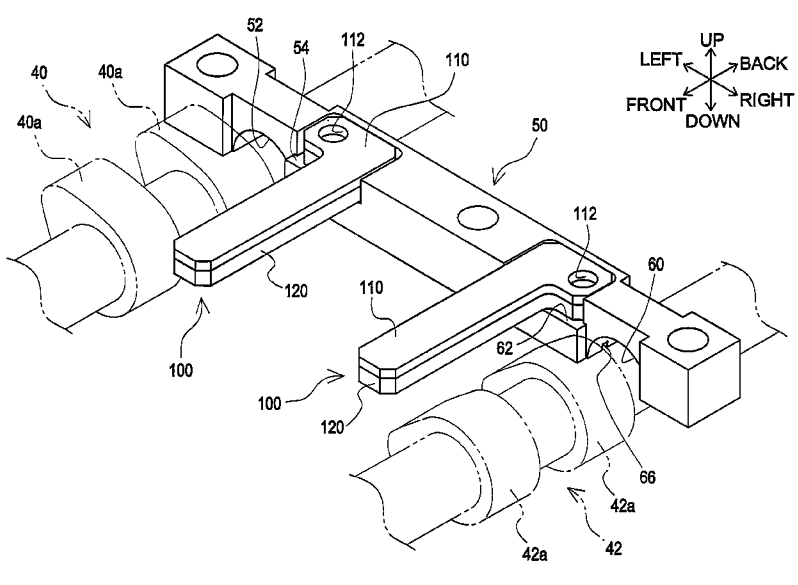

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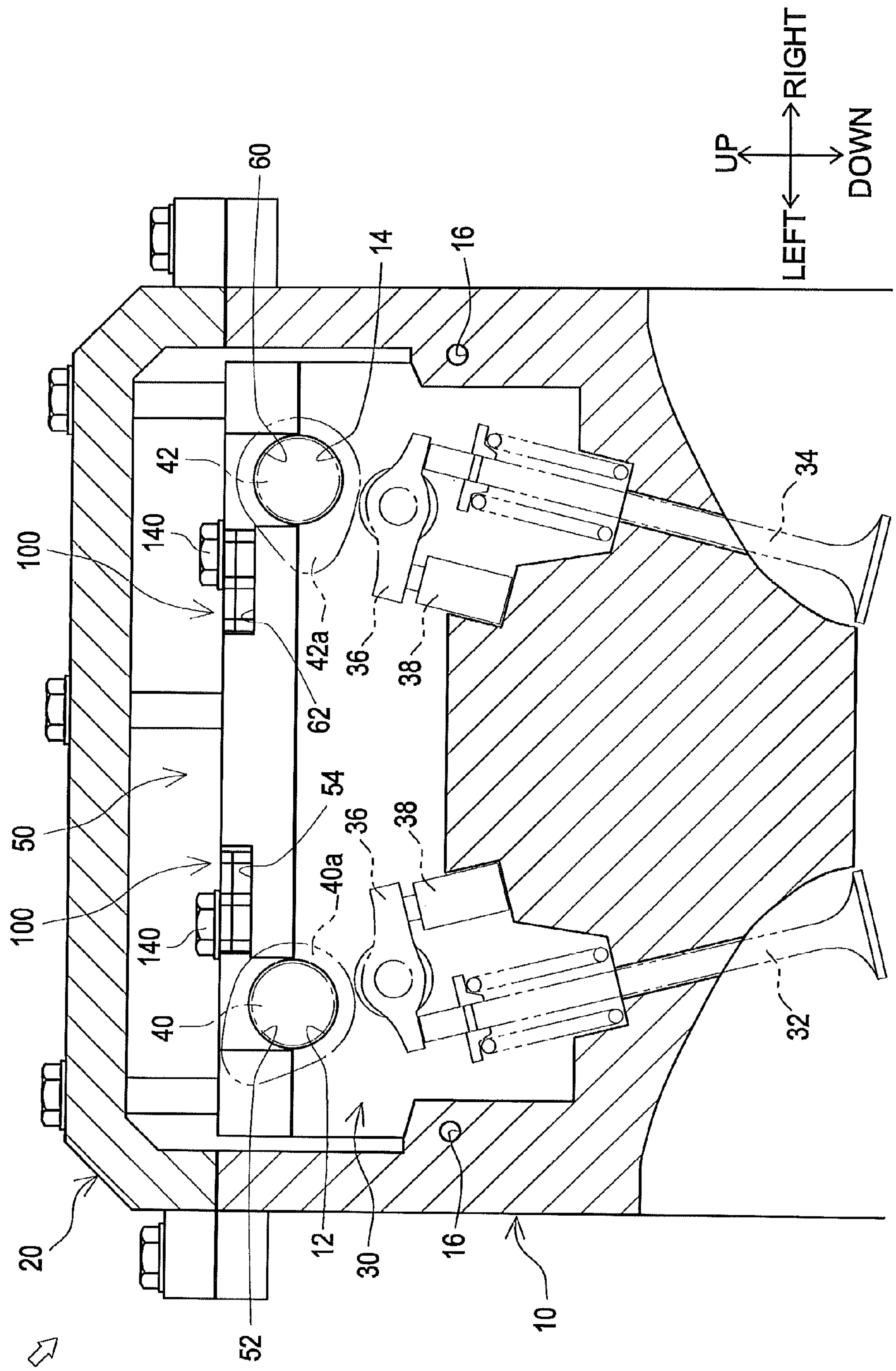
FIG. 1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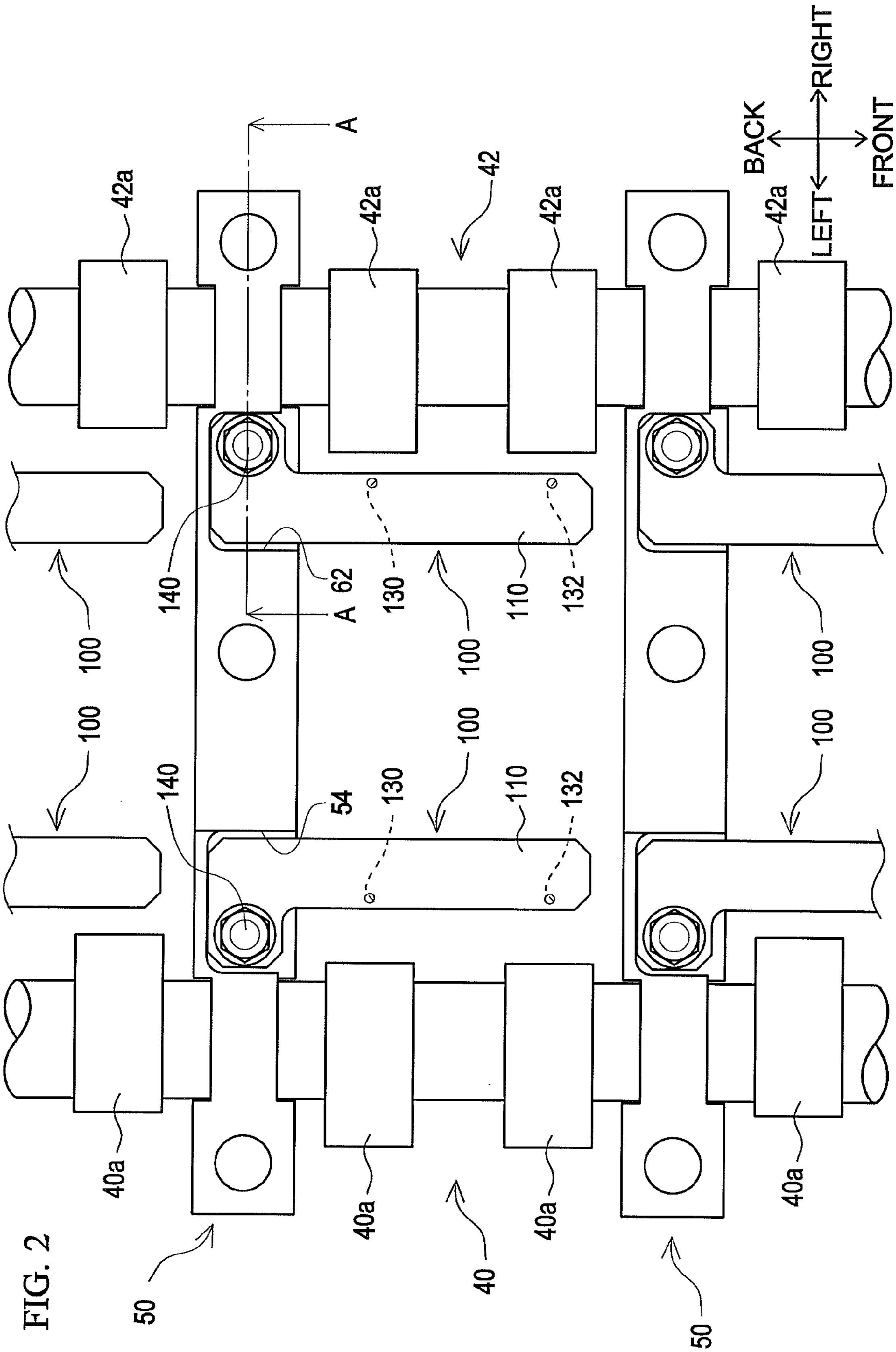

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FIG. 2

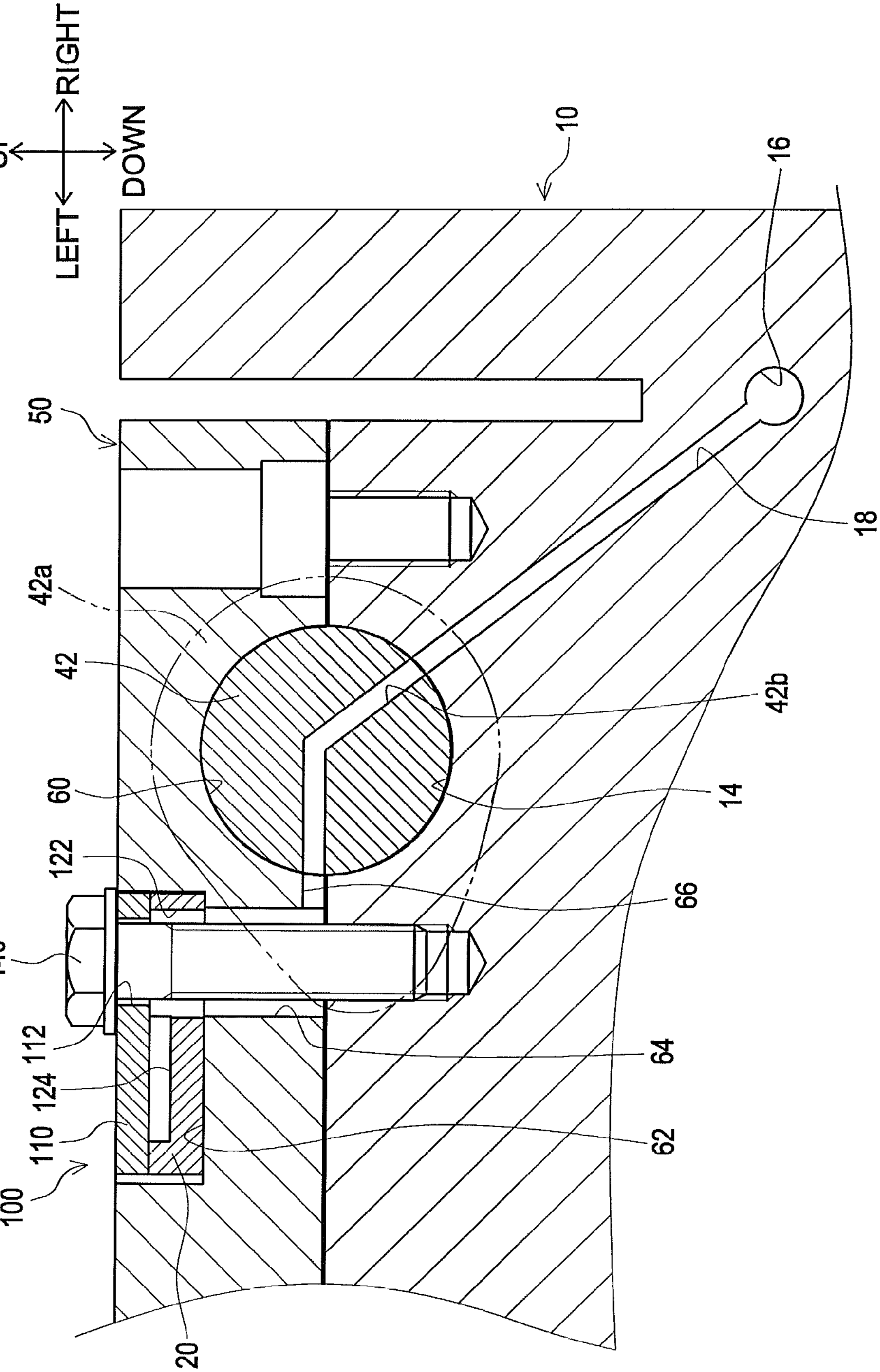
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FIG. 3

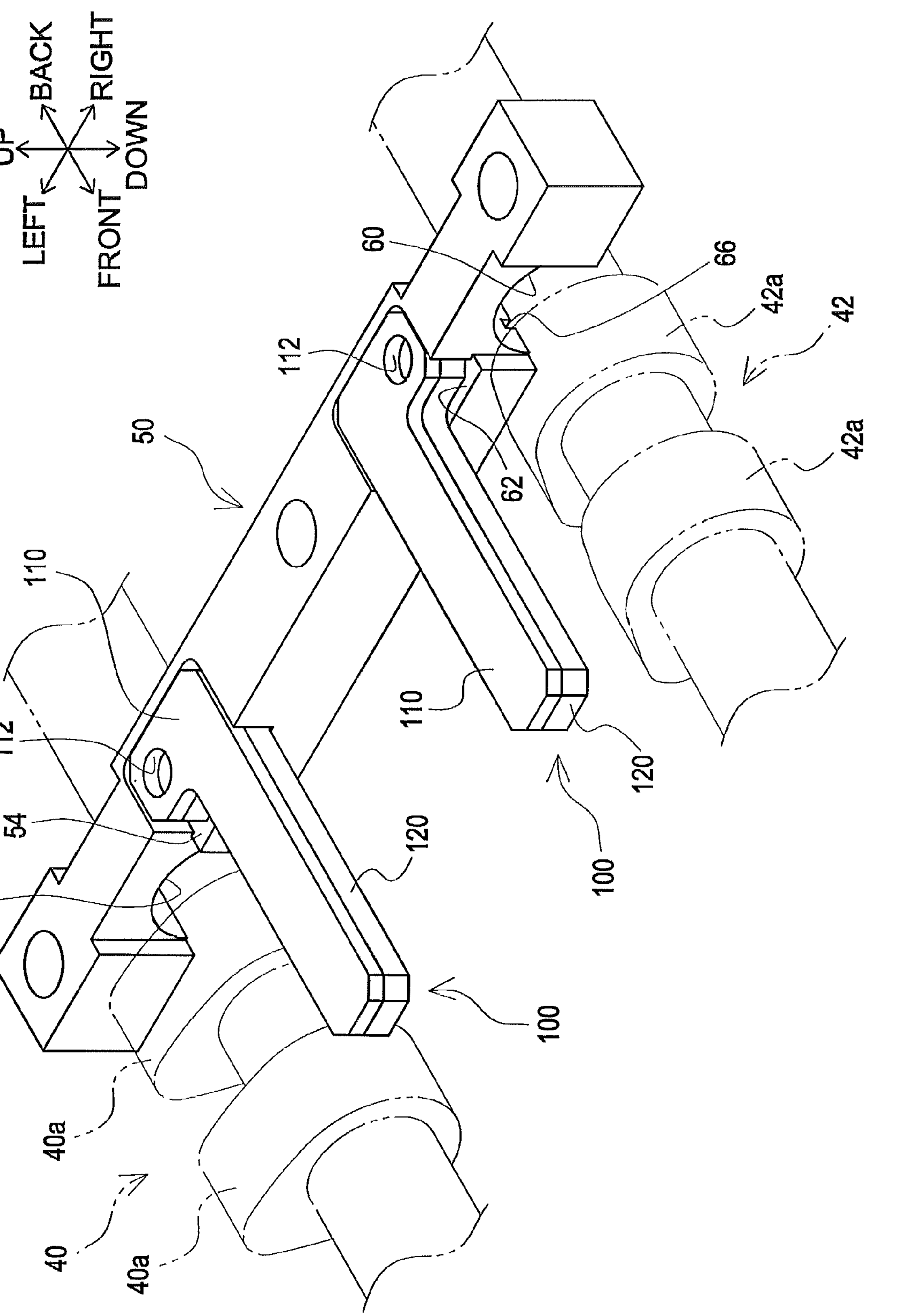
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FIG. 4

FIG. 5

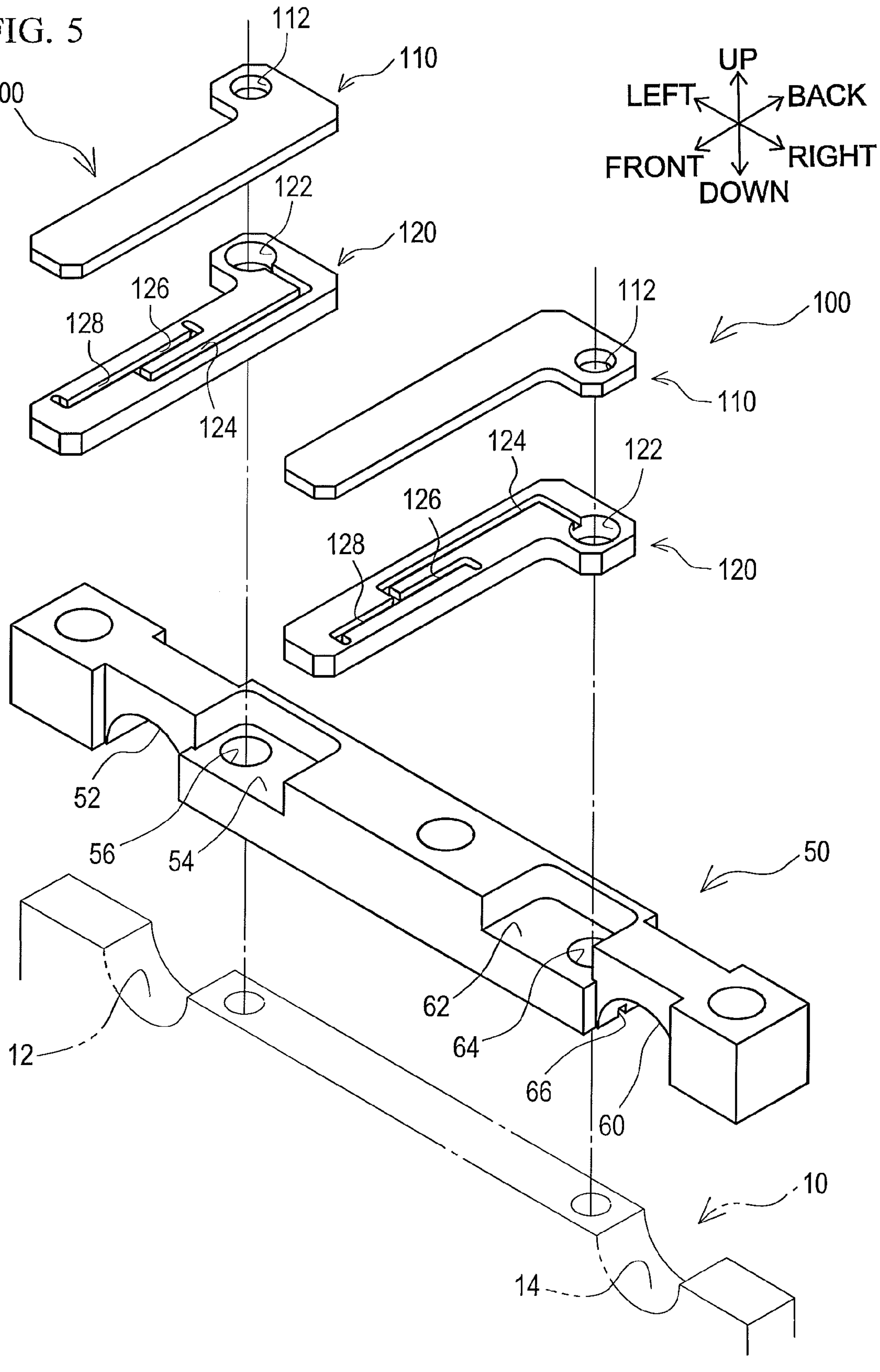

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FIG. 6A

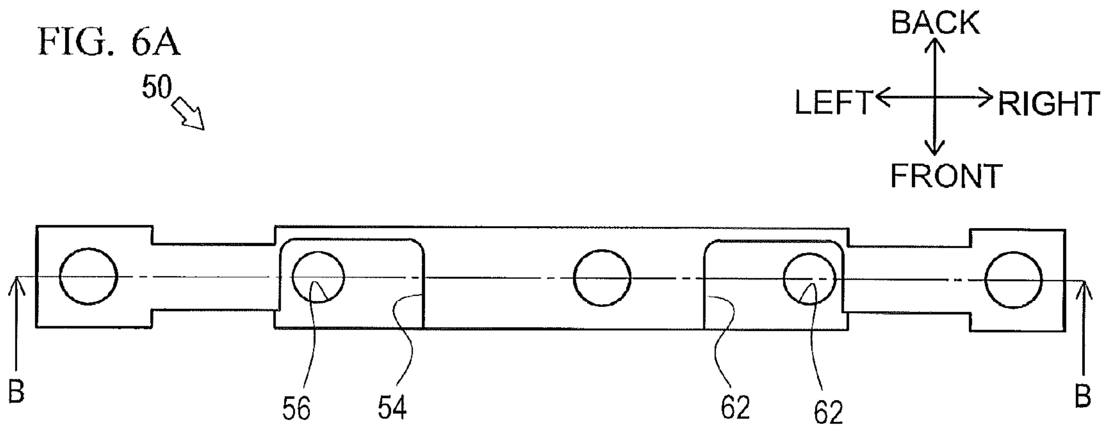


FIG. 6B

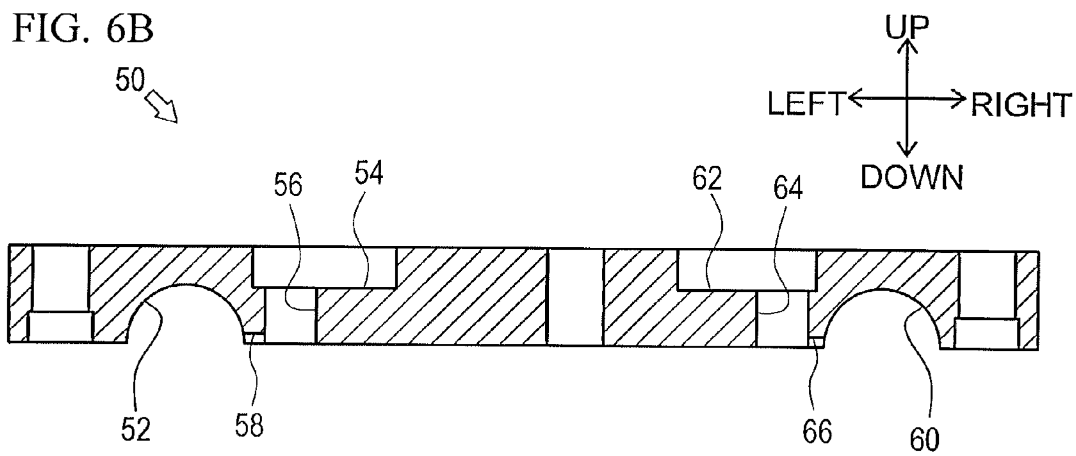


FIG. 6C

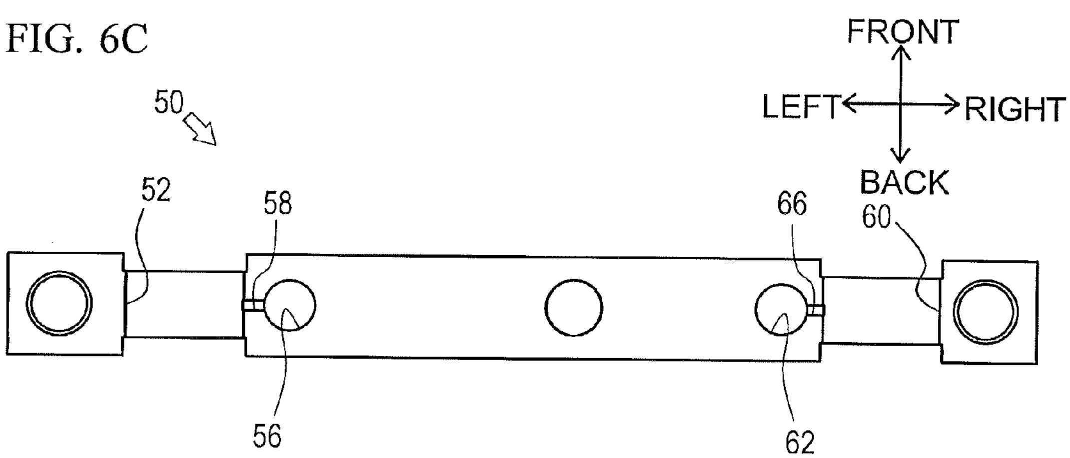

FIG. 7A

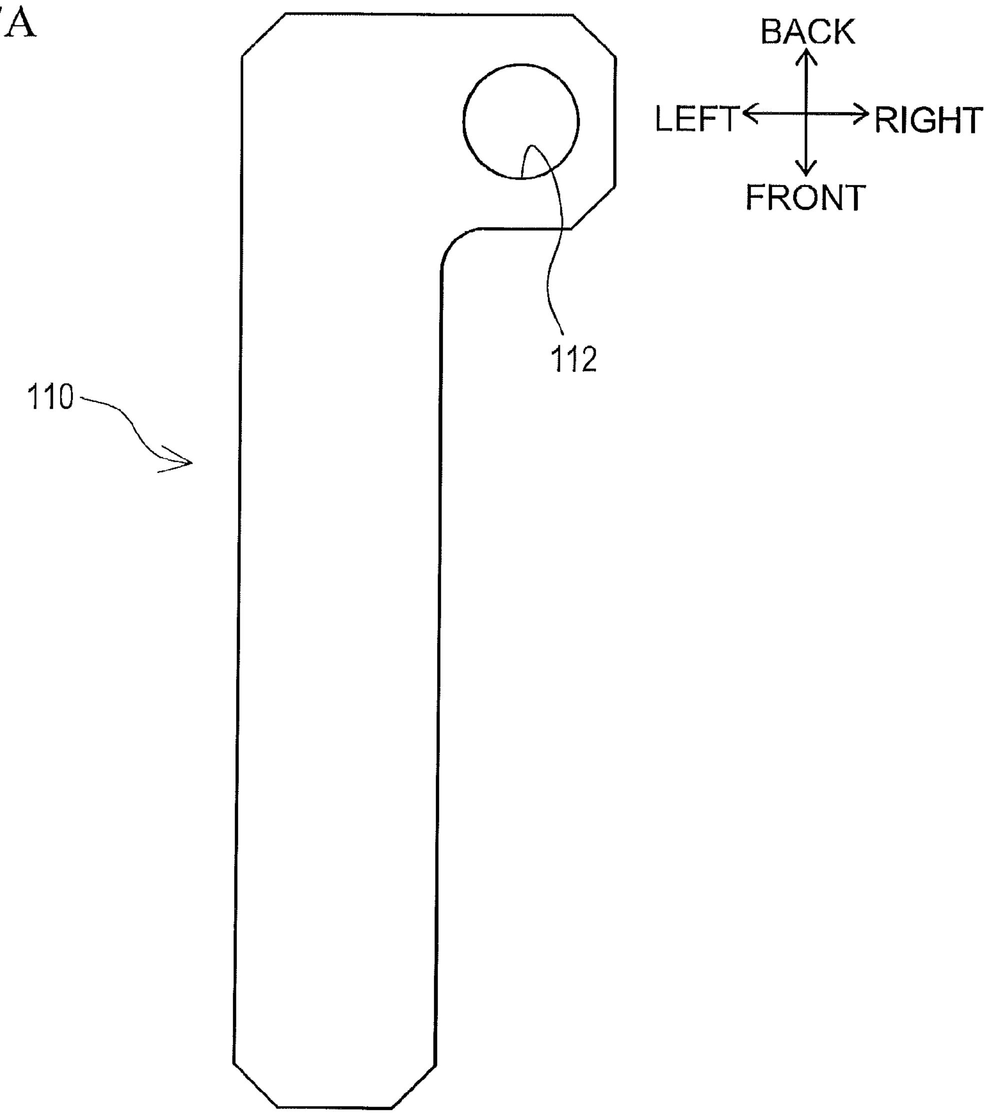


FIG. 7B

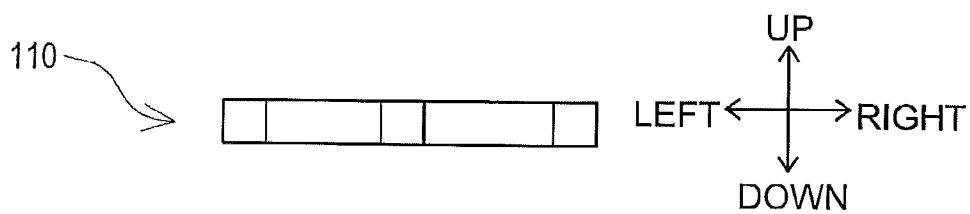

FIG. 8A

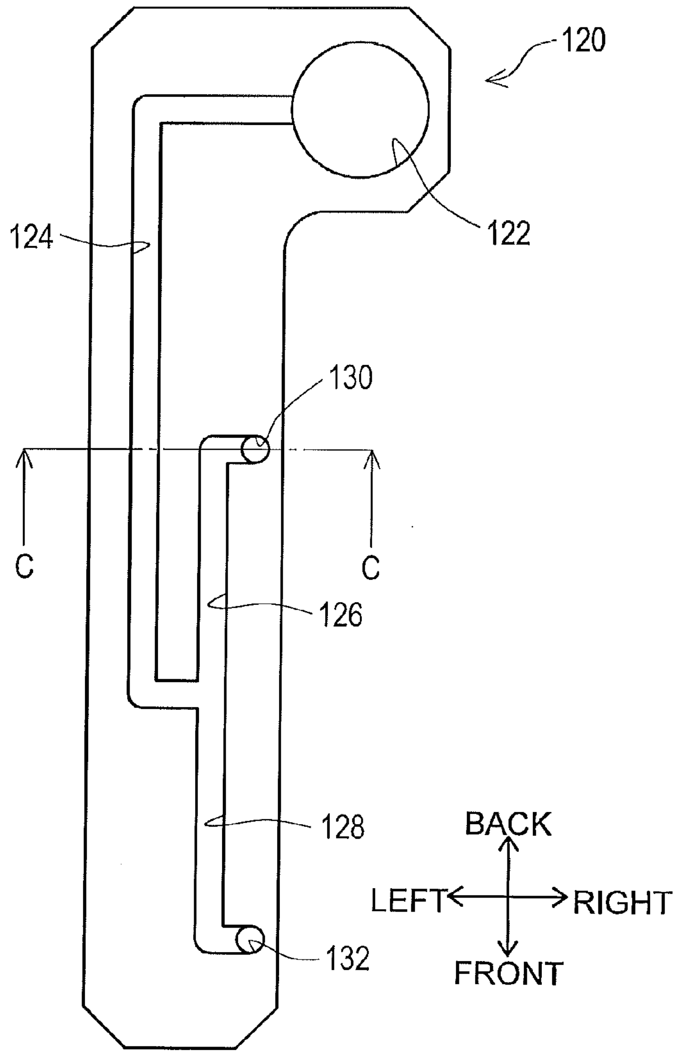


FIG. 8B

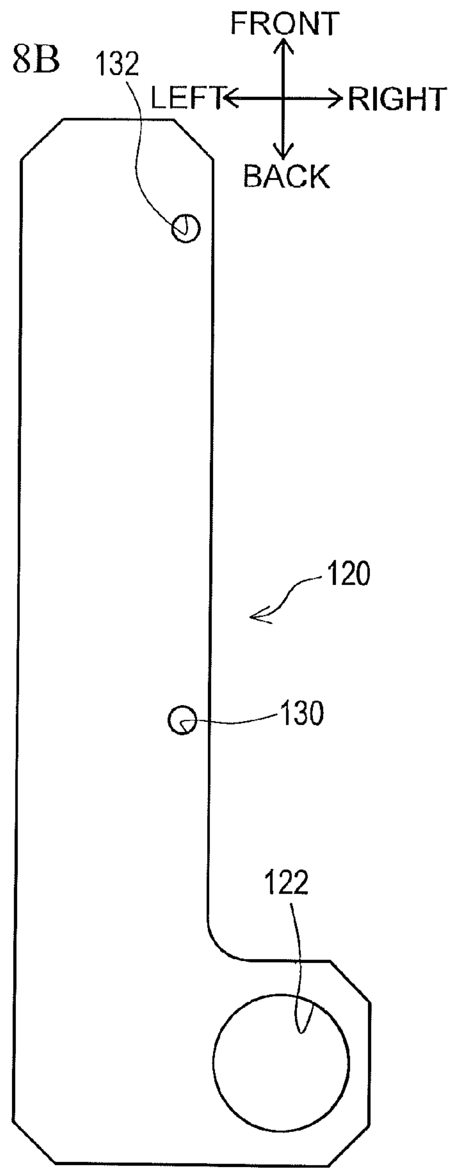


FIG. 8C

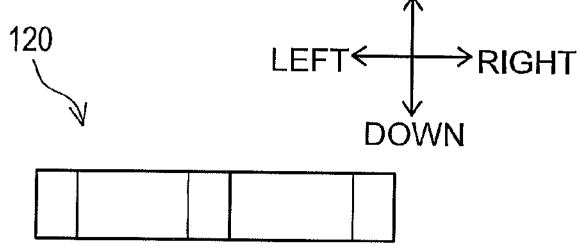


FIG. 8D

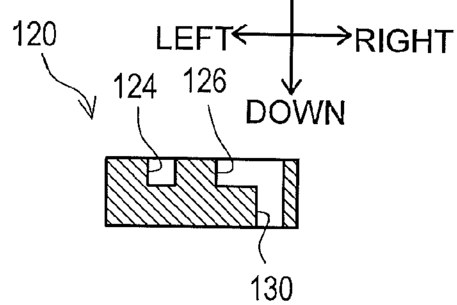

FIG. 9A

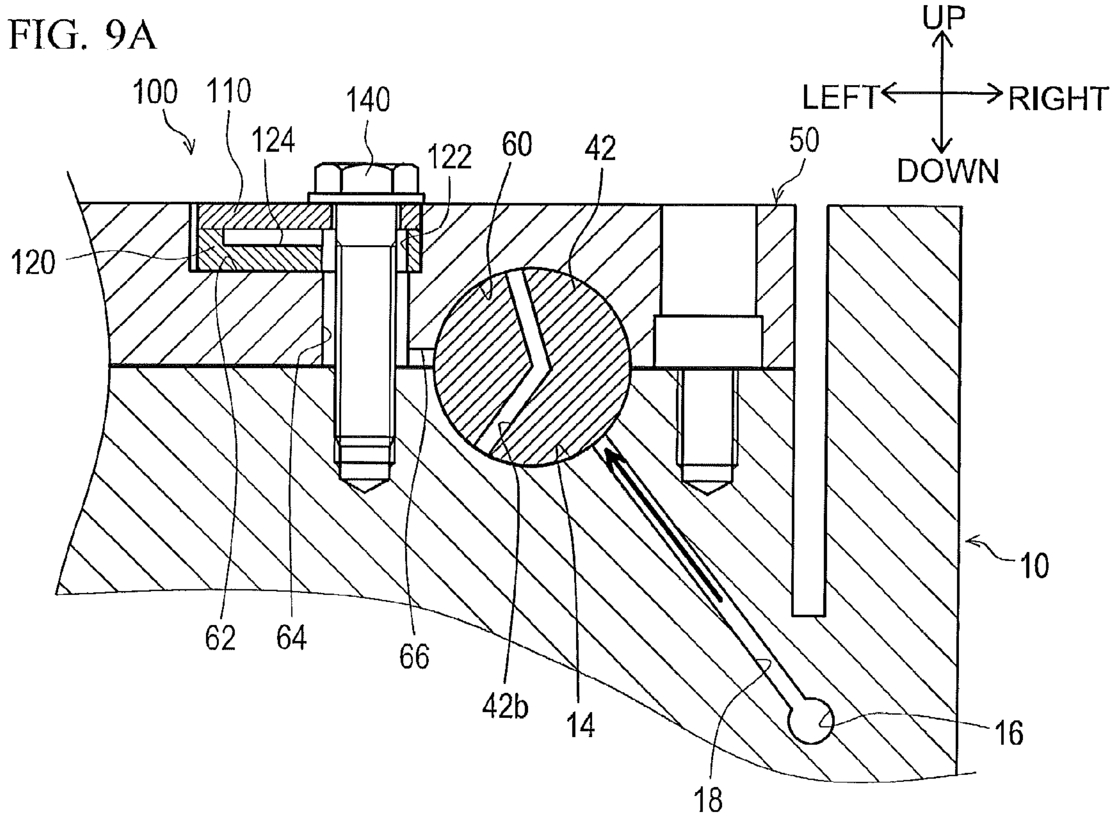
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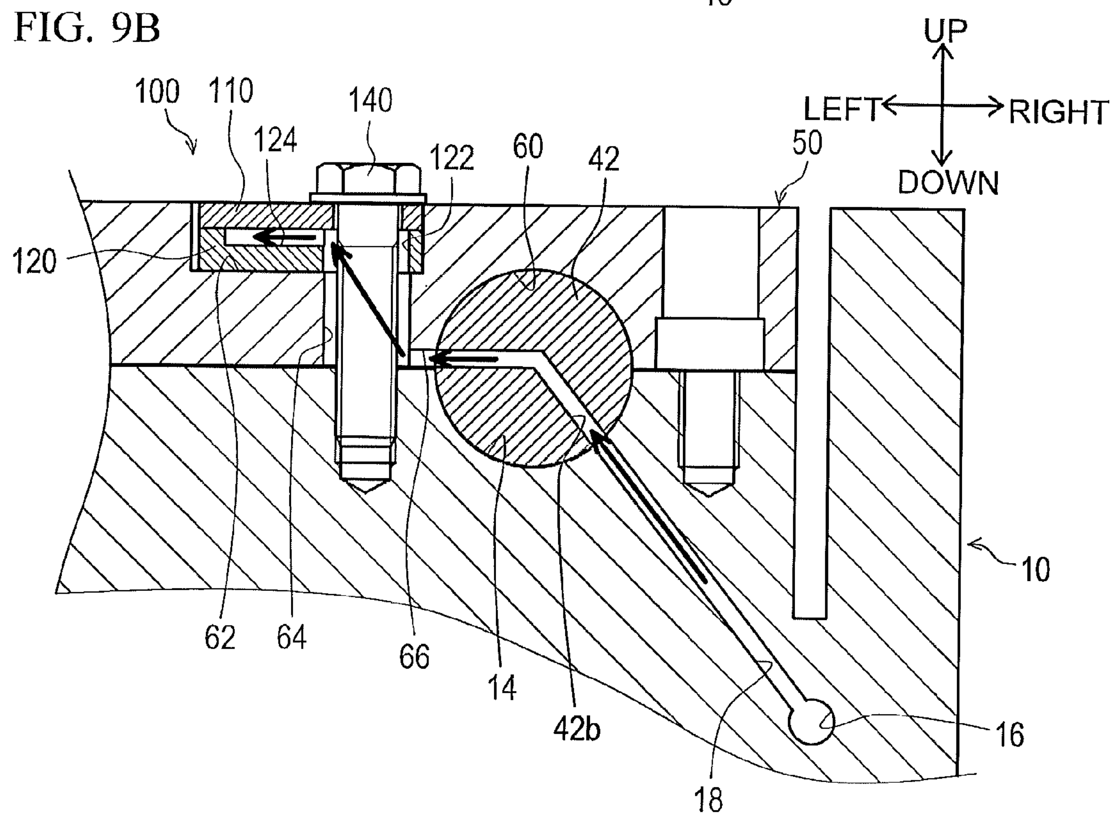
FIG. 9B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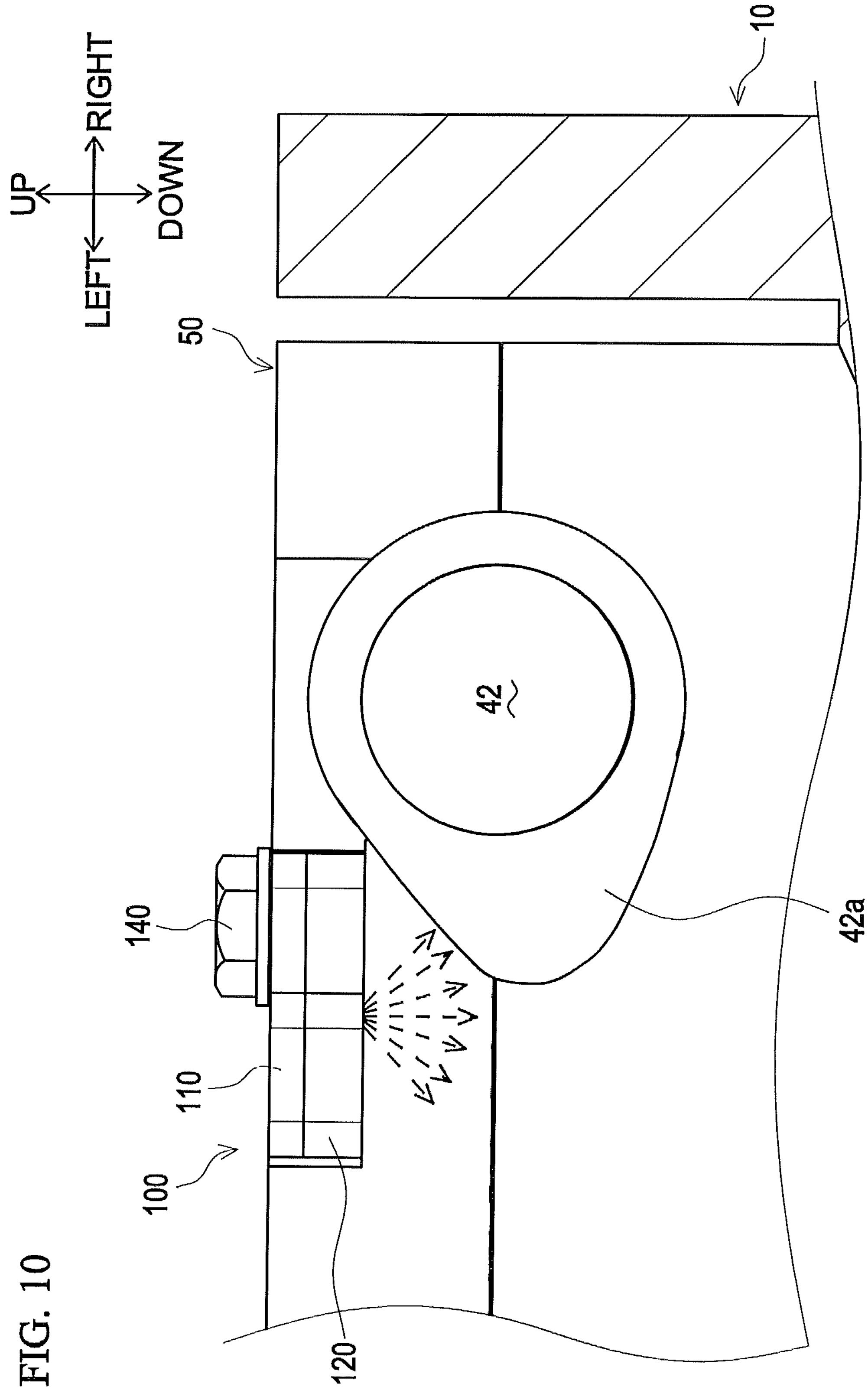


FIG. 10

FIG. 11A

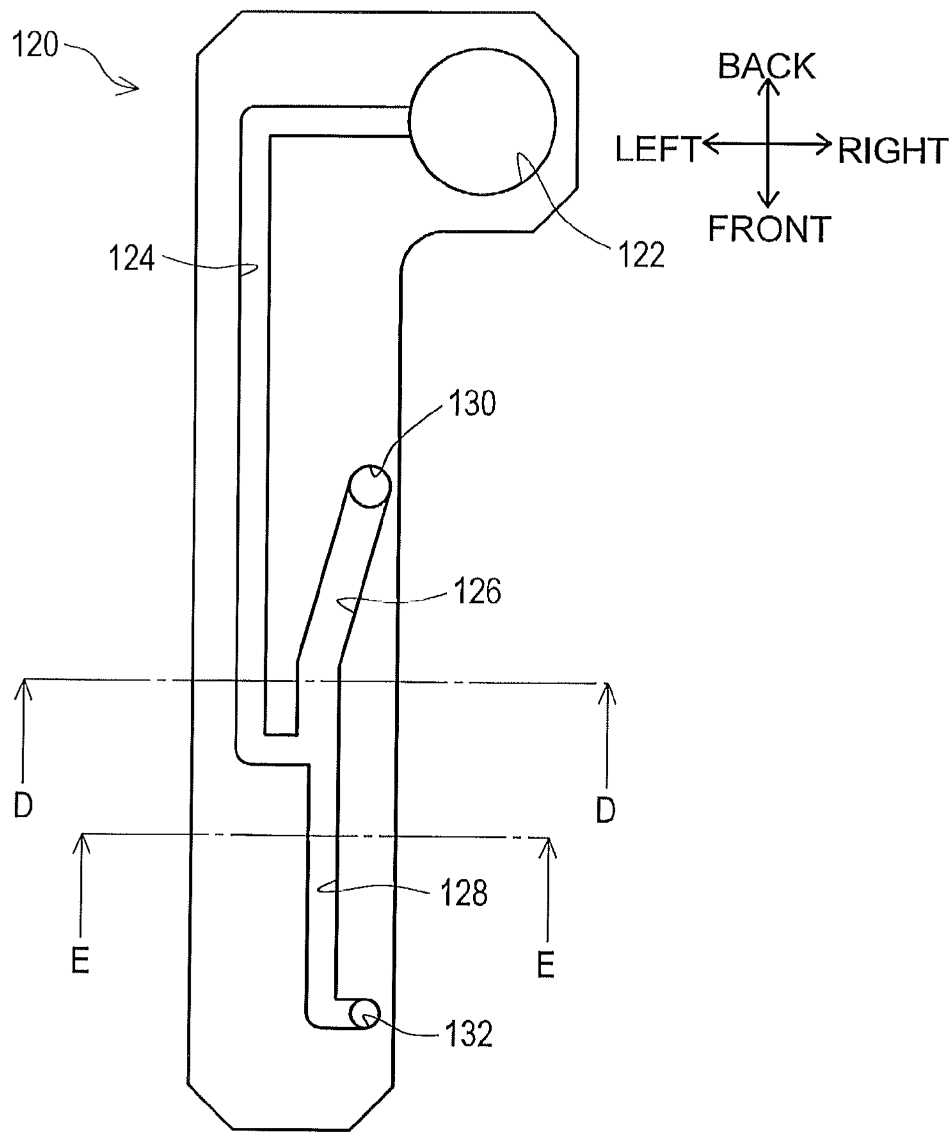


FIG. 11B

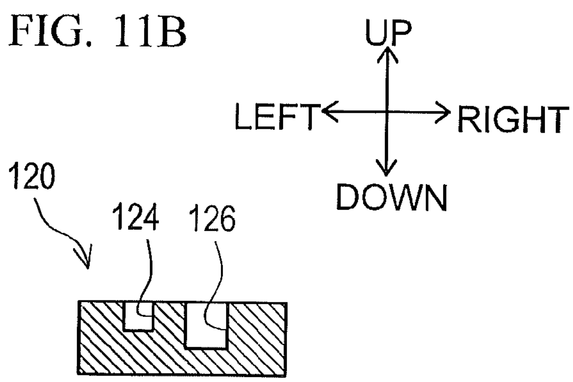


FIG. 11C

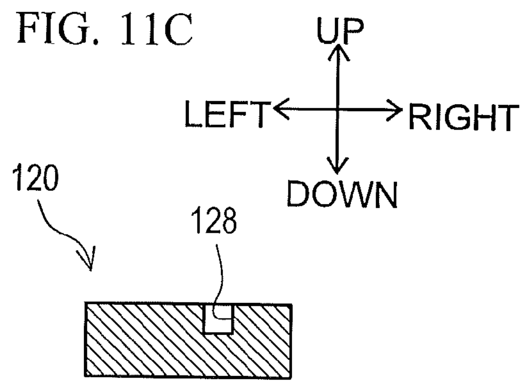

FIG. 12

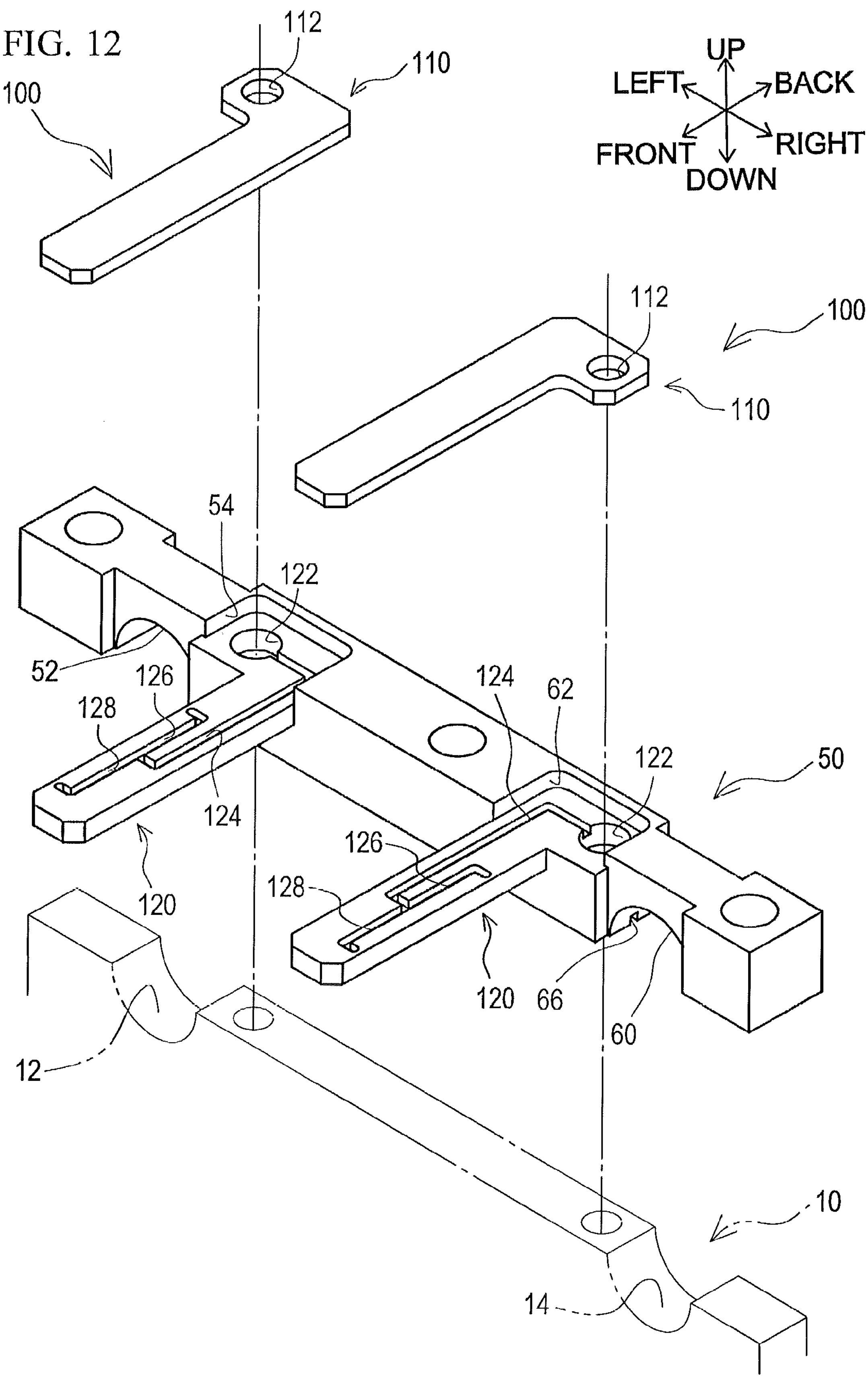

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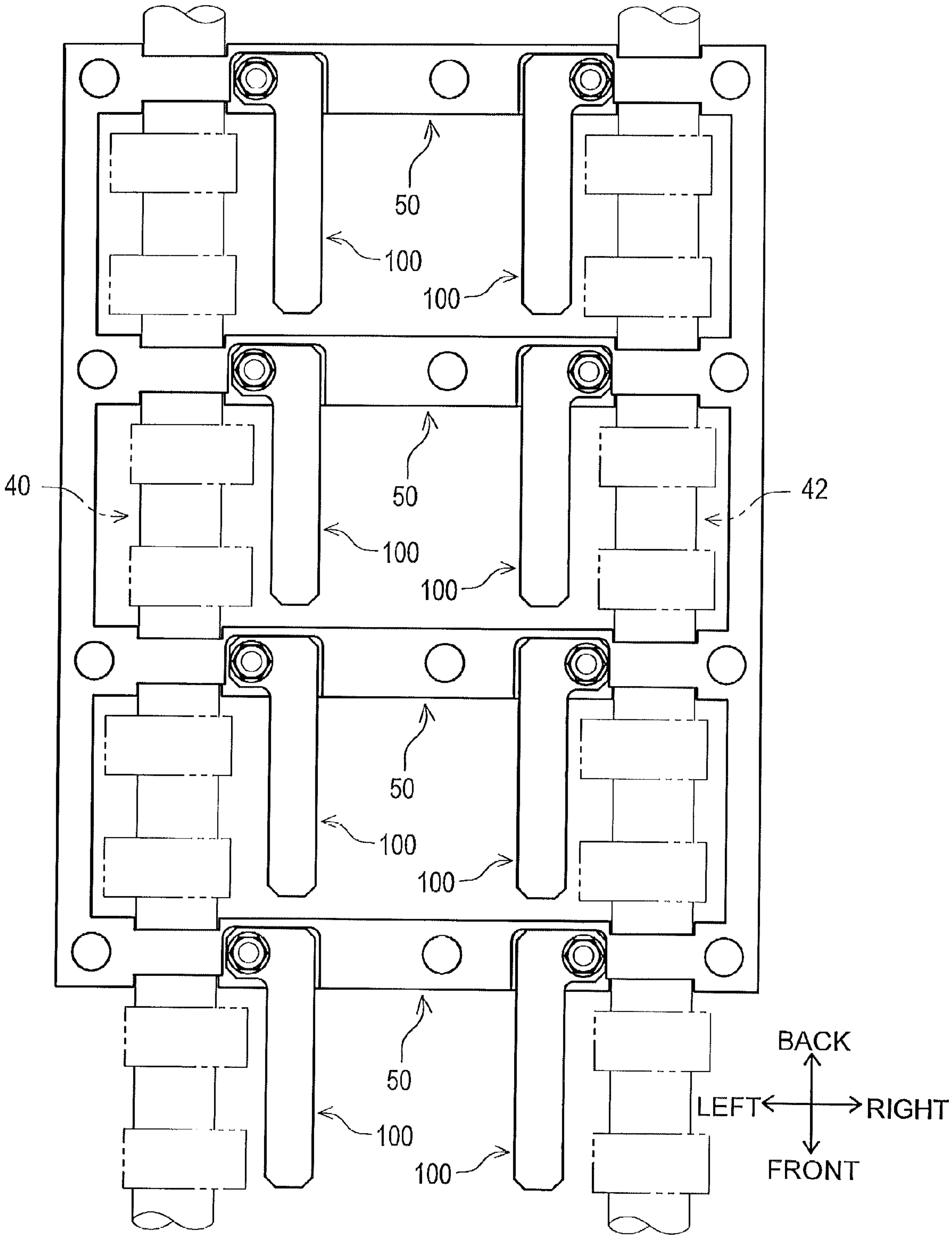
FIG. 13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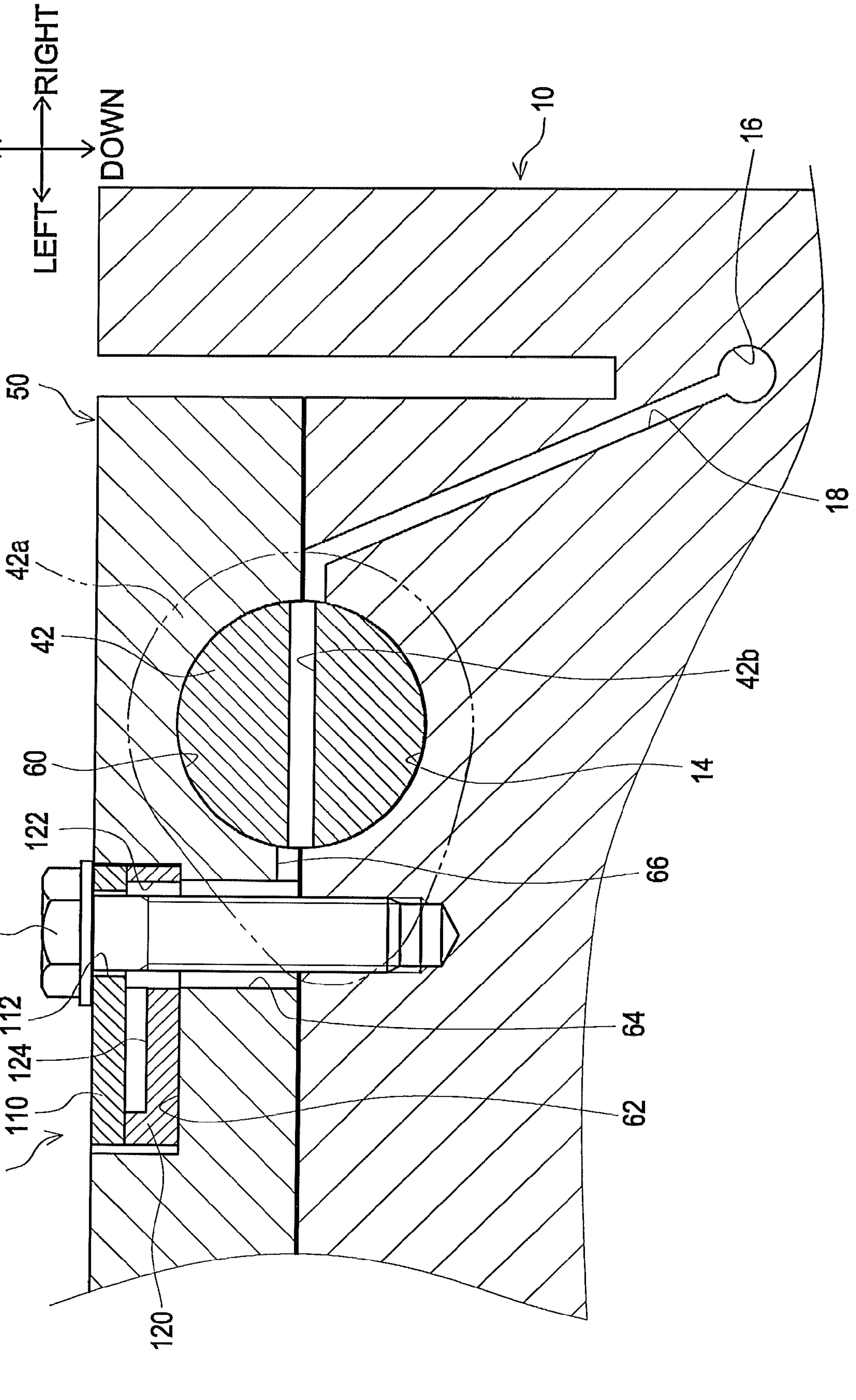
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FIG. 14

# LUBRICANT FEED MECHANISM FOR ENGINE

## TECHNICAL FIELD

The present invention relates to a technology of a lubricant feed mechanism for an engine for feeding lubricant to a cam of a valve gear through a cylinder head, a camshaft, and a cam cap.

## BACKGROUND ART

A technology of a lubricant feed mechanism for an engine has been known by which lubricant is fed to a cam of a valve gear through a cylinder head, a camshaft, and a cam cap. Examples include JP-A-2010-164009.

A lubricant feed mechanism for an engine described in JP-A-2010-164009 includes a cylinder head having a bearing, a camshaft rotatably supported by the bearing, a cam cap fixedly attached to the cylinder head from the upper side to hold the camshaft therewith, and a cam shower pipe connected to an upper portion of the cam cap.

Further, the lubricant feed mechanism includes a communicating oil passage from an oil gallery of the cylinder head to the camshaft (bearing), an oil passage penetrating the camshaft (cam journal), and a communicating oil passage that is provided in the cam cap and connects the camshaft to the cam shower pipe.

In the lubricant feed mechanism thus configured, lubricant that circulates in the oil gallery can be fed to a plurality of cams of a valve gear through the cylinder head, the camshaft, the cam cap, and the cam shower pipe. Thus, lubricant of a substantially equal amount is fed to the plurality of cams by extracting lubricant from the oil gallery of a relatively large diameter, i.e., with a less pressure loss.

However, according to the technology described in JP-A-2010-164009, the cam shower pipe for feeding lubricant to the cams is positioned at an upper portion of the cam cap. Typically, the upper portion of a cam cap is covered with a cylinder head cover, and not much space is left above the cam cap. Hence, in actually applying the technology described in JP-A-2010-164009, the cam shower pipe may interfere with another member, such as a baffle plate positioned at the cylinder head cover side, which may involve additional design changes to avoid the interference.

## DISCLOSURE OF THE INVENTION

### Problems to be Solved by the Invention

The present invention was made in view of the foregoing circumstances, in order to provide a lubricant feed mechanism for an engine of which the use of the space above a cam cap is dispensed with.

### Solutions to the Problems

A problem to be solved by the present invention is as described above, and techniques for solving the problem are described next.

More specifically, a lubricant feed mechanism for an engine according to the present invention is configured to feed lubricant to a cam of a valve gear through a cylinder head, a camshaft, and a cam cap. The mechanism includes an oil feed member disposed in the cam cap such that an upper end of the oil feed member is set at a lower level than an upper end of the cam cap in a height-wise direction, and the oil feed member has an oil passage configured to guide lubricant to be fed through the cam cap to the cam.



In the lubricant feed mechanism for an engine according to the present invention, the cam cap may have a recess provided around a bolt opening for fixedly attaching the cam cap to the cylinder head, and the oil feed member may have a portion contained within the recess and may be fixedly attached to the cylinder head together with the cam cap by a bolt.

In the lubricant feed mechanism for an engine according to the present invention, the oil feed member may include a plurality of panel members laid over each other, and the oil passage in the oil feed member may be entirely or partly a groove carved on at least one surface on which the panel members of the oil feed member abut each other.

In the lubricant feed mechanism for an engine according to the present invention, the oil passage in the oil feed member may have two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed an equal amount of lubricant to the two cams.

In the lubricant feed mechanism for an engine according to the present invention, the oil passage in the oil feed member may have two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed any different amounts of lubricant to the two cams.

In the lubricant feed mechanism for an engine according to the present invention, the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member may be integrally provided with the cam cap having the oil feed member disposed thereon.

The lubricant feed mechanism for an engine according to the present invention may include a plurality of cam caps identical to the cam cap, the cam caps being integrally provided.

### Effects of the Invention

The present invention provides effects as follows.

With the lubricant feed mechanism for an engine according to the present invention, lubricant is fed to a cam without using the space above the cam cap. With this configuration, interference between members is prevented, and design changes for avoiding the interference are obviated.

With the lubricant feed mechanism for an engine according to the present invention, the oil feed member is secured by using an existing bolt (a bolt for fixedly attaching the cam cap to the cylinder head). Thus, addition of a separate fastening member such as a bolt is dispensed with, and the number of components is reduced.

With the lubricant feed mechanism for an engine according to the present invention, formation of oil passages in the oil feed member is facilitated.

With the lubricant feed mechanism for an engine according to the present invention, two cams are lubricated equally.

With the lubricant feed mechanism for an engine according to the present invention, the amounts of lubricant to be fed, i.e., the oil feed amounts, to two cams may be deliberately made different. This allows for independent adjustment of the amount of lubricant to be fed to the two cams as desired.

With the lubricant feed mechanism for an engine according to the present invention, attachment of the oil feed member and the cam cap is facilitated with respect to the cylinder head.

With the lubricant feed mechanism for an engine according to the present invention, attachment of the cam cap is facilitated with respect to the cylinder head.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of the inside of a cylinder head cover of an engine according to a first embodiment of the present invention.

FIG. **2** is a plan view depicting cam caps and oil feed members.

FIG. **3** is a cross-sectional view taken along line A-A in FIG. **2**.

FIG. **4** is a perspective view depicting the cam cap and the oil feed members.

FIG. **5** is an exploded perspective view of the members depicted in FIG. **4**.

FIG. **6**A is a plan view depicting the cam cap, FIG. **6**B is a front cross-sectional view depicting a cross section of the cam cap taken along line B-B, and FIG. **6**C is a bottom view depicting the cam cap.

FIG. **7**A is a plan view of a first panel member, and FIG. **7**B is a front view of the first panel member.

FIG. **8**A is a plan view depicting a second panel member, FIG. **8**B is a bottom view of the second panel member, FIG. **8**C is a front view of the second panel member, and FIG. **8**D is a front cross-sectional view depicting a cross section of the second panel member taken along line C-C.

FIG. **9**A is a cross-sectional view taken along line A-A in FIG. **2** where lubricant is not fed to an in-shaft oil passage, and FIG. **9**B is a cross-sectional view taken along line A-A in FIG. **2** where lubricant is fed to the in-shaft oil passage.

FIG. **10** is a front view depicting a state in which lubricant is discharged from the oil feed member to a cam.

FIG. **11**A is a plan view depicting a second panel member according to a second embodiment, FIG. **11**B is a front cross-sectional view depicting a cross section of the second panel member taken along line D-D, and FIG. **11**C is a front cross-sectional view depicting a cross section of the second panel member taken along line E-E.

FIG. **12** is an exploded perspective view depicting a cam cap and oil feed members according to a third embodiment.

FIG. **13** is a plan view depicting a cam cap according to a fourth embodiment.

FIG. **14** is a front cross-sectional view depicting an exhaust-side camshaft according to a fifth embodiment.

## EMBODIMENTS OF THE INVENTION

In the description below, the up-down direction, the right-left direction, and the front-back direction are defined by the arrows depicted in the figures.

First, description is given with reference to FIGS. **1** to **8**D of a configuration of an engine **1** including a lubricant feed mechanism according to a first embodiment of the present invention.

The engine **1** according to the present embodiment is an inline 4-cylinder double overhead camshaft (DOHC) 16-valve gasoline engine. Description is given below mainly focusing on one cylinder of the four cylinders arranged in the front-back direction. The engine **1** mainly includes a cylinder head **10**, a cylinder head cover **20**, a valve gear **30**, cam caps **50**, and oil feed members **100**.

The cylinder head **10** depicted in FIGS. **1**, **3**, and **5** makes a principal structural body of the engine **1** together with a cylinder block (not shown). The cylinder head **10** is fixedly attached to an upper portion of the cylinder block (not shown). The cylinder head **10** mainly includes a bearing **12** on the intake-side, a bearing **14** on the exhaust-side, an oil gallery **16**, and a cam journal oil passage **18**.

The intake-side bearing **12** depicted in FIGS. **1** and **5** rotatably supports from the lower side an intake-side camshaft **40** to be described later. The intake-side bearing **12** is provided at a left portion of the cylinder head **10** so as to be recessed in a semicircular shape with the upper side open in front view.

The exhaust-side bearing **14** depicted in FIGS. **1**, **3**, and **5** rotatably supports from the lower side an exhaust-side camshaft **42** to be described later. The exhaust-side bearing **14** is provided at a right portion of the cylinder head **10** so as to be recessed in a semicircular shape with the upper side open in front view.

The oil gallery **16** depicted in FIGS. **1** and **3** is an oil passage for guiding lubricant to various portions of the engine **1**, such as a lash adjuster **38** to be described later. The oil gallery **16** is provided so as to pass the vicinity of a right and left sidewalls of the cylinder head **10** in the front-back direction.

The cam journal oil passage **18** depicted in FIG. **3** is provided at a right portion of the cylinder head **10** so as to guide lubricant to the exhaust-side bearing **14**. The cam journal oil passage **18** has one end communicating with the oil gallery **16**, whereas the cam journal oil passage **18** has the other end communicating with the exhaust-side bearing **14** of the cylinder head **10**.

Although not illustrated in the present embodiment, the cam journal oil passage **18** is also provided at a left portion of the cylinder head **10** to communicate the oil gallery **16** on the left side with the intake-side bearing **12**.

The cylinder head cover **20** depicted in FIG. **1** covers over the cylinder head **10**. The cylinder head cover **20** is placed on an upper portion of the cylinder head **10** and is appropriately secured thereto by, for example, a bolt.

The valve gear **30** depicted in FIG. **1** is configured to open and close an intake port and an exhaust port (not shown) of the engine **1** at a predetermined timing. The valve gear **30** mainly includes an intake valve **32**, an exhaust valve **34**, rocker arms **36**, lash adjusters **38**, the intake-side camshaft **40**, and the exhaust-side camshaft **42**.

The intake valve **32** is configured to open and close the intake port (not shown) of the engine **1**. The intake valve **32** is positioned with the longitudinal direction thereof directed substantially in the up-down direction. The intake valve **32** has a lower end extended to the intake port.

Although not illustrated in the present embodiment, two intake valves **32** are arranged in line in the front-back direction with respect to one cylinder.

The exhaust valve **34** is configured to open and close the exhaust port (not shown) of the engine **1**. The exhaust valve **34** is positioned with the longitudinal direction thereof directed substantially in the up-down direction. The exhaust valve **34** has a lower end extended to the exhaust port.

Although not illustrated in the present embodiment, two exhaust valves **34** are arranged in line in the front-back direction with respect to one cylinder.

The rocker arms **36** are configured to openably/closably drive the intake valve **32** and the exhaust valve **34**. The rocker arms **36** have one ends that abut the respective upper ends of the intake valve **32** and the exhaust valve **34** from the upper side.

The lash adjusters **38** are configured to adjust valve clearances. The lash adjusters **38** each abut the respective the other ends of the rocker arms **36** from the lower side.

The intake-side camshaft **40** depicted in FIGS. **1**, **2**, and **4** is configured to rock a rocker arm **36** at a predetermined timing so as to openably/closably drive the intake valve **32**. The intake-side camshaft **40** is placed on the intake-side bearing **12** of the cylinder head **10** with the longitudinal direction thereof directed in the front-back direction. The intake-side camshaft **40** mainly includes cams **40***a*.

The cams **40***a* are portions that have a planar shape with a non-uniform distance from the center of rotation, i.e., the center of the intake-side camshaft **40**, to the outer periphery. Two cams **40***a* are arranged in line at a portion frontward of the portion (the cam journal) of the intake-side camshaft **40** placed on the intake-side bearing **12** of the cylinder head **10**. The cams **40***a* abut the rocker arm **36** on the intake valve **32** side from the upper side.

The exhaust-side camshaft **42** depicted in FIGS. **1**, **2**, and **4** is configured to rock a rocker arm **36** at a predetermined timing so as to openably/closably drive the exhaust valve **34**. The exhaust-side camshaft **42** is placed on the exhaust-side bearing **14** of the cylinder head **10** with the longitudinal direction thereof directed in the front-back direction. The exhaust-side camshaft **42** mainly includes cams **42***a* and an in-shaft oil passage **42***b*.

The cams **42***a* are portions that have a planar shape with a non-uniform distance from the center of rotation, i.e., the center of the exhaust-side camshaft **42**, to the outer periphery. Two cams **42***a* are arranged in line at a portion frontward of the portion (the cam journal) of the exhaust-side camshaft **42** placed on the exhaust-side bearing **14** of the cylinder head **10**. The cams **42***a* abut the rocker arm **36** on the exhaust valve **34** side from the upper side.

The in-shaft oil passage **42***b* depicted in FIG. **3** is provided in the portion (the cam journal) of the exhaust-side camshaft **42** placed on the exhaust-side bearing **14** of the cylinder head **10** and penetrates the exhaust-side camshaft **42**. The in-shaft oil passage **42***b* is configured such that one end thereof, i.e., one of the openings thereof, opposes the cam journal oil passage **18** in the cylinder head **10** and the other end thereof, i.e., the other opening, faces leftward when the exhaust-side camshaft **42** rotates to a predetermined position.

Although not illustrated in the present embodiment, an oil passage similar to the in-shaft oil passage **42***b* in the exhaust-side camshaft **42** is provided in the intake-side camshaft **40**.

The cam caps **50** depicted in FIGS. **1** to **6**C are fixedly attached to the upper portion of the cylinder head **10** so as to hold the intake-side camshaft **40** and the exhaust-side camshaft **42** with the cylinder head **10**. The cam caps **50** have a substantially rectangular parallelpiped shape with the longitudinal direction thereof directed in the right-left direction.

The cam caps **50** each mainly include a bearing **52** on the intake side, a recess **54** on the intake side, a throughhole **56** on the intake side, a communicating oil passage **58** on the intake side, a bearing **60** on the exhaust side, a recess **62** on the exhaust side, a throughhole **64** on the exhaust side, and a communicating oil passage **66** on the exhaust side.

The intake-side bearing **52** depicted in FIGS. **4** to **5** and **6**B and **6**C rotatably supports the intake-side camshaft **40** from the upper side. The intake-side bearing **52** is provided at a left portion of a cam cap **50** so as to be semicircularly recessed with the lower side open in front view. The intake-side bearing **52** of the cam cap **50** is provided at a position opposing the intake-side bearing **12** of the cylinder head **10**, and the intake-side camshaft **40** is rotatably supported (held) between the intake-side bearing **52** and the intake-side bearing **12**.

The intake-side recess **54** is provided at a left portion on the upper surface of the cam cap **50**, i.e., immediately rightward of the intake-side bearing **52** in the right-left direction. The intake-side recess **54** is configured so as to be recessed downward to a certain depth from the periphery thereof and to be opened at the upper and front sides thereof.

The intake-side throughhole **56** depicted in FIGS. **5** to **6**C is a bolt opening through which a bolt **140** to be described later is inserted to fixedly attach the cam cap **50** to the cylinder head **10**. The intake-side throughhole **56** is provided so as to penetrate from a left portion on the bottom surface of the intake-side recess **54** to the lower surface of the cam cap **50**. In other words, the intake-side recess **54** is provided around the upper end of the intake-side throughhole **56**. The intake-side throughhole **56** has a diameter that is larger than the diameter of a shaft portion of the bolt **140** to be described later, namely, a diameter that will leave a gap between the intake-side throughhole **56** and the bolt **140** when the shaft portion of the bolt **140** is inserted through the intake-side throughhole **56**.

The intake-side communicating oil passage **58** depicted in FIGS. **6**B and **6**C is configured to communicate the intake-side bearing **52** with the intake-side throughhole **56**. The intake-side communicating oil passage **58** is provided at a substantially front-back-wise central portion on the lower surface of the cam cap **50**. The intake-side communicating oil passage **58** has one end communicating with the intake-side bearing **52**, and the intake-side communicating oil passage **58** has the other end communicating with the intake-side throughhole **56**.

The exhaust-side bearing **60** depicted in FIGS. **3** to **5** and **6**B and **6**C rotatably supports the exhaust-side camshaft **42** from the upper side. The exhaust-side hearing **60** is provided at a right portion of the cam cap **50** so as to be semicircularly recessed with the lower side open in front view. The exhaust-side bearing **60** of the cam cap **50** is provided at a position opposing the exhaust-side bearing **14** of the cylinder head **10**, and the exhaust-side camshaft **42** is rotatably supported (held) between the exhaust-side bearing **60** and the exhaust-side bearing **14**.

The exhaust-side recess **62** is provided at a right portion on the upper surface of the cam cap **50**, i.e., immediately leftward of the exhaust-side bearing **60** in the right-left direction. The exhaust-side recess **62** is configured so as to be recessed downward to a certain depth from the periphery thereof and to be opened at the front and upper sides thereof.

The exhaust-side throughhole **64** depicted in FIGS. **3** and **5** and **6**B is a bolt opening through which a bolt **140** to be described later is inserted to fixedly attach the cam cap **50** to the cylinder head **10**. The exhaust-side throughhole **64** is provided so as to penetrate from a right portion on the bottom surface of the exhaust-side recess **62** to the lower surface of the cam cap **50**. In other words, the exhaust-side recess **62** is provided around the upper end of the exhaust-side throughhole **64**. The exhaust-side throughhole **64** has a diameter that is larger than the diameter of the shaft portion of the bolt **140** to be described later, namely, a diameter that will leave a gap between the exhaust-side throughhole **64** and the bolt **140** when the shaft portion of the bolt **140** is inserted through the exhaust-side throughhole **64**.

The exhaust-side communicating oil passage **66** depicted in FIGS. **3** to **5** and **6**B and **6**C is configured to communicate the exhaust-side bearing **60** with the exhaust-side throughhole **64**. The exhaust-side communicating oil passage **66** is provided at a substantially front-back-wise central portion on the lower surface of the can cap **50**. The exhaust-side communicating oil passage **66** has one end communicating with the exhaust-side bearing **60**, and the exhaust-side communicating oil passage **66** has the other end communicating with the exhaust-side throughhole **64**.

The oil feed members **100** depicted in FIGS. **1** to **5** are configured to guide lubricant to a cam **40***a* of the intake-side camshaft **40** and a cam **42***a* of the exhaust-side camshaft **42**.

Since the configuration of the oil feed member **100** for guiding lubricant to a cam **40***a* of the intake-side camshaft **40**, i.e., the oil feed member **100** positioned on the left side, is right-left symmetrical with respect to the configuration of the oil feed member **100** for guiding lubricant to a cam **42***a* of the exhaust-side camshaft **42**, i.e., the oil feed member **100** positioned on the right side, detailed description is specifically given of the oil feed member **100** positioned on the right side, and description is not given of the oil feed member **100** positioned on the left side.

The oil feed member **100** is formed by laying a plurality of (two in the present embodiment) panel members over one another. The oil feed member **100** mainly includes a first panel member **110** and a second panel member **120**.

The first panel member **110** depicted in FIGS. **5** and **7**A and **7**B is a planer member configuring an upper portion of the oil feed member **100**. The first panel member **110** is positioned with the planer surface thereof directed in the up-down direction. The first panel member **110** has a substantially L-shape in plan view. More specifically, the first panel member **110** is shaped so as to have a shorter side directed in the right-left direction and a longer side extended from a left end portion of the shorter side toward the front. A throughhole **112** is provided in the vicinity of the right end portion of the shorter side of the first panel member **110** so as to penetrate the first panel member **110** in the up-down direction.

The second panel member **120** depicted in FIGS. **5** and **8**A to **8**D is a planar member configuring a lower portion of the oil feed member **100**. The second panel member **120** is positioned with the planar surface thereof directed in the up-down direction. The second panel member **120** has a substantially L-shape in plan view like the first panel member **110**.

The second panel member **120** mainly includes a throughhole **122**, a first oil passage **124**, a second oil passage **126**, a third oil passage **128**, a first discharge port **130**, and a second discharge port **132**.

The throughhole **122** penetrates the second panel member **120** in the up-down direction. The throughhole **122** is provided at a position that is in the vicinity of the right end portion of the shorter side of the second panel member **120** and overlaps the throughhole **112** in the first panel member **110** in plan view. The throughhole **122** has a diameter that is larger than the diameter of the shaft portion of the bolt **140** to be described later, namely, a diameter that will leave a gap between the throughhole **122** and the bolt **140** when the shaft portion of the bolt **140** is inserted through the throughhole **122**.

The first oil passage **124** is a groove that is provided on the upper surface of the second panel member **120** and is carved for guiding lubricant. The first oil passage **124** has one end communicating with the throughhole **122**. The first oil passage **124** is extended leftward from the throughhole **122**, is extended frontward from a left end portion to which the passage is extended leftward, and is extended rightward from a front end portion to which the passage is extended frontward.

The second oil passage **126** is a groove that is provided on the upper surface of the second panel member **120** and is carved for guiding lubricant. The second oil passage **126** has one end communicating with the other end, i.e., the right front end, of the first oil passage. The second oil passage **126** is extended backward from the other end, i.e., the right front end, of the first oil passage **124** and is extended rightward from a back end portion to which the passage is extended backward.

The third oil passage **128** is a groove that is provided on the upper surface of the second panel member **120** and is carved for guiding lubricant. The third oil passage **128** has one end communicating with the other end, i.e., the right front end, of the first oil passage. The third oil passage **128** is extended frontward from the other end, i.e., the right front end, of the first oil passage **124** and is extended rightward from a front end portion to which the passage is extended frontward.

As described above, the second oil passage **126** and the third oil passage **128** are provided so as to branch off from the other end, i.e., the right front end, of the first oil passage **124**. Further, the second oil passage **126** and the third oil passage **128** are provided symmetrically in the front-back direction with respect to the axis in the right-left direction that passes the branch point in the first oil passage **124**, i.e., the other end of the first oil passage **124**. Further, the second oil passage **126** and the third oil passage **128** are configured so as to have an identical cross-sectional shape.

The first discharge port **130** is an aperture that penetrates the second panel member **120** in the up-down direction for discharging lubricant downward of the second panel member **120**. The first discharge port **130** is provided so as to communicate the other end, i.e., the right back end, of the second oil passage **126** with the lower surface of the second panel member **120**.

The second discharge port **132** is an aperture that penetrates the second panel member **120** in the up-down direction for discharging lubricant downward of the second panel member **120**. The second discharge port **132** is provided so as to communicate the other end, i.e., the right front end, of the third oil passage **128** with the lower surface of the second panel member **120**.

The second discharge port **132** has an identical shape (cross-sectional shape) with that of the first discharge port **130**.

As depicted in FIGS. **4** and **5**, the first panel member **110** configured as above is laid over the second panel member **120**, namely, the lower surface of the first panel member **110** and the upper surface of the second panel member **120** are brought into abutment with each other, and are secured by using, for example, a bolt (not shown), so as to configure the oil feed member **100**. In so doing, the first oil passage **124**, the second oil passage **126**, and the third oil passage **128** that are provided on the second panel member **120** are closed with the first panel member **110** from the upper side, thus allowing lubricant to be guided from the throughhole **122** to the first discharge port **130** and to the second discharge port **132**. In other words, the throughhole **122**, the first oil passage **124**, the second oil passage **126**, the third oil passage **128**, the first discharge port **130**, and the second discharge port **132** configure an oil passage through which lubricant circulates.

Also as depicted in FIGS. **3** to **5**, the back end portion of the oil feed member **100**, i.e., the shorter side portions of the first panel member **110** and the second panel member **120**, is contained within the exhaust-side recess **62** in the cam cap **50**. The throughholes in the oil feed member **100**, i.e., the throughhole **112** in the first panel member **110** and the throughhole **122** in the second panel member **120**, are arranged so as to overlap the exhaust-side throughhole **64** in the cam cap **50** in plan view. The bolt **140** is inserted through the throughholes from the upper side, such that the bolt **140** is fastened to the cylinder head **10**. In this manner, the oil feed member **100** is fixedly attached to the cam cap **50** by the bolt **140**, and the cam cap **50** is fixedly attached to the cylinder head **10**.

In so doing, the thickness of the oil feed member **100**, i.e., a total of the thicknesses in the up-down direction of the first panel member **110** and the second panel member **120**, is set so as to be the same or smaller than the depth of the exhaust-side recess **62** in the cam cap **50**. Thus, the upper end of the oil feed member **100** comes at a lower level than the upper end of the cam cap **50** in a height-wise direction (in the up-down direction) even after the oil feed member **100** is secured to the cam cap **50**, and the oil feed member **100** does not project upward from the cam cap **50**.

Further, when the oil feed member **100** is secured to the cam cap **50**, as depicted in FIG. **2**, the first discharge port **130** and the second discharge port **132** are each disposed so as to hold the same positions as the cams **42***a* on the exhaust-side camshaft **42** in the front-back direction. Hence, the first discharge port **130** and the second discharge port **132** are each located approximately above the cams **42***a* on the exhaust-side camshaft **42**.

Description is given below with reference to FIGS. **8**A to **10** of modes of feeding lubricant to the cams **42***a* on the exhaust-side camshaft **42** by using the lubricant feed mechanism for the engine **1** configured as above.

It is to be noted that, since the mode of feeding lubricant to the cams **40***a* on the intake-side camshaft **40** by using the lubricant feed mechanism for the engine **1** is substantially the same, description thereof is not given below.

As depicted in FIG. **9**A, the engine **1** is driven to cause the exhaust-side camshaft **42** to rotate, and the lubricant circulating through the oil gallery **16** is fed through the cam journal oil passage **18** to the exhaust-side bearing **14** when the one end of the in-shaft oil passage **42***b* does not oppose the cam journal oil passage **18** in the cylinder head **10**. The lubricant is not fed into the in-shaft oil passage **42***b* but lubricates the sliding surface between the exhaust-side camshaft **42** and the exhaust-side bearing **14** (and the exhaust-side bearing **60**).

As depicted in FIG. **9**B, per 360-degree rotation of the exhaust-side camshaft **42**, the one end of the in-shaft oil passage **42***b* opposes the cam journal oil passage **18** in the cylinder head **10** once, and the other end of the in-shaft oil passage **42***b* also opposes the exhaust-side communicating oil passage **66**. In this case, lubricant flowing in the oil gallery **16** is fed through the cam journal oil passage **18** into the in-shaft oil passage **42***b*. Further, the lubricant is fed through the in-shaft oil passage **42***b* and the exhaust-side communicating oil passage **66** into the exhaust-side throughhole **64**. The bolt **140** is inserted through the exhaust-side throughhole **64**, while a gap is provided between the exhaust-side throughhole **64** and the bolt **140**, thus allowing the lubricant to circulate inside the exhaust-side throughhole **64**. The lubricant flows upward in the exhaust-side throughhole **64** and is fed to the oil feed member **100**, more specifically, into the throughhole **122** in the second panel member **120**.

The lubricant fed to the throughhole **122** in the second panel member **120** flows in the first oil passage **124** and is fed being branched from the other end, i.e., the right front end, of the first oil passage **124** to the second oil passage **126** and to the third oil passage **128** (see, for example, FIG. **8**A to **8**D). The lubricant fed to the second oil passage **126** is discharged downward through the first discharge port **130**. The lubricant fed to the third oil passage **128** is discharged downward through the second discharge port **132**. As indicated by the broken line in FIG. **10**, the lubricant discharged from the first discharge port **130** and the second discharge port **132** in the oil feed member **100** is fed to the cams **42***a* that are arranged at the lower side of the first discharge port **130** and the second discharge port **132**, thus lubricating the cams **42***a*.

In this manner, lubricant is fed to the cams **42***a* when the exhaust-side camshaft **42** rotates by a predetermined angle. More specifically, lubricant is intermittently, i.e., once during one rotation of the exhaust-side camshaft **42**, to the cams **42***a*. Thus, lubricant is not fed constantly to the cams **42***a*, which allows for prevention of excessive feeding of lubricant to the cams **42***a*.

The second oil passage **126** and the third oil passage **128** are provided so as to be symmetrical in the front-back direction in plan view and to have an identical cross-sectional shape. More specifically, the second oil passage **126** and the third oil passage **128** are configured to have the same length, cross-sectional shape, number of turns, and angle of turning. With this configuration, the lubricant fed from the first oil passage **124** has a substantially equal pressure loss in flowing the second oil passage **126** and the third oil passage **128**; thus, the flow rate of lubricant is substantially the same in the second oil passage **126** and in the third oil passage **128**. Hence, a substantially equal amount of lubricant is fed to the cams **42***a*.

As above, the lubricant feed mechanism for the engine **1** according to the present embodiment is configured to feed lubricant to a cam (a cam **40***a* and a cam **42***a*) of a valve gear **30** through a cylinder head **10**, a camshaft (an intake-side camshaft **40** and an exhaust-side camshaft **42**), and a cam cap **50**. The mechanism includes an oil feed member **100** that is disposed in the cam cap **50** such that an upper end thereof is set at a lower level than an upper end of the cam cap **50** in the height-wise direction, and that has an oil passage (a first oil passage **124**, a second oil passage **126**, and a third oil passage **128**) configured to guide lubricant to be fed through the cam cap **50** to the cam **40***a* and the cam **42***a*.

This configuration allows for feeding of lubricant to the cam **40***a* and the cam **42***a* without using the space above the cam cap **50**. In this manner, interference among members is prevented, and design changes to avoid the interference are obviated.

The cam cap **50** has a recess (an intake-side recess **54** and an exhaust-side recess **62**) provided around a bolt opening (an intake-side throughhole **56** and an exhaust-side throughhole **64**) for fixedly attaching the cam cap **50** to the cylinder head **10**, and the oil feed member **100** has a portion contained within the recess and is fixedly attached to the cylinder head **10** together with the cam cap **50** by a bolt **140**.

With this configuration, the oil feed member **100** is secured by using an existing bolt **140**, i.e., a bolt for fixedly attaching the cam cap **50** to the cylinder head **10**, by which the use of an additional fastening member, such as a separately provided bolt, is dispensed with; thus, the number of components is reduced.

The oil feed member **100** includes a plurality of (two) panel members (a first panel member **110** and a second panel member **120**) laid over each other, and a portion of the oil passage (a first oil passage **124**, a second oil passage **126**, and a third oil passage **128**) in the oil feed member **100** is a groove carved on at least one surface (the upper surface of the second panel member **120**) on which the two panel members of the oil feed member **100** abut each other.

This configuration facilitates formation of oil passages in the oil feed member **100**.

The oil passage in the oil feed member **100** has two branches (the second oil passage **126** and the third oil passage **128**) from a middle portion of the oil passage in such a manner as to guide lubricant to two cams **42***a*, and to feed an equal amount of lubricant to the two cams **42***a*.

This configuration allows for equal lubrication of the two cams **42***a*.

It is to be noted that, while the engine **1** according to the present embodiment is described as an inline 4-cylinder DOHC 16-valve gasoline engine, engines to which the present invention is applicable are not limited thereto.

Further, while in the present embodiment, oil passages in the oil feed member **100**, i.e., the first oil passage **124**, the second oil passage **126**, and the third oil passage **128**, are provided on the second panel member **120**, the present invention is not limited thereto. More specifically, it is also conceivable that the passages are provided on the first panel member **110**, or that the passages are provided on both the first panel member **110** and the second panel member **120**, namely, the passages are provided at least one of the surfaces on which the panel members abut each other.

Further, the shape of the oil feed member **100** is not limited to the substantially L-shape in plan view as in the present embodiment, and the shape may be any shape insofar as lubricant is feedable to the cams, i.e., a cam **40***a* and a cam **42***a*.

Further, while in the present embodiment, the oil feed member **100** includes two panel members, i.e., the first panel member **110** and the second panel member **120**, the present invention is not limited thereto. More specifically, for example, the oil feed member **100** may include a pipe insofar as the oil feed member **100** does not project upward from the cam cap **50**.

Further, while in the present embodiment, the oil feed member **100** includes two panel members, i.e., the first panel member **110** and the second panel member **120**, the present invention is not limited thereto. More specifically, the oil feed member **100** may include three or more panel members laid over one another. In this case, a groove is carved on any of the surfaces on which the plurality of (three or more) panel members abut each other so as to form an oil passage for guiding lubricant.

Further, while in the present embodiment, the oil feed member **100** includes a plurality of (two) panel members, i.e., the first panel member **110** and the second panel member **120**, laid over each other, it is also conceivable that a seal member such as a gasket is interposed between the plurality of panel members.

Further, while in the present embodiment, the oil passage in the oil feed member **100** branches into two, i.e., the second oil passage **126** and the third oil passage **128**, from a middle portion thereof, i.e., the first oil passage **124**, the present invention is not limited thereto. More specifically, the oil passages in the oil feed member **100** may take a configuration of branching into two from an upstream end portion thereof, namely, the configuration in which two oil passages are provided from the beginning and not one oil passage branches from a middle portion.

Description is given below of other embodiments of the lubricant feed mechanism for an engine according to the present invention.

As a second embodiment, the second oil passage **126** and the third oil passage **128** provided on the second panel member **120** may, as depicted in FIGS. **11**A to **11**C, have any lengths, cross-sectional shapes, numbers of turns, or angles of turning that are different from each other.

Specifically, in the second panel member **120** depicted in FIGS. **11**A to **11**C, the second oil passage **126** is larger in cross-sectional shape, namely, is wider and deeper, than the third oil passage **128**. Further, the second oil passage **126** is configured to bend more moderately than the third oil passage **128**, and thus the second oil passage **126** has a shorter length than the third oil passage **128**.

In this manner, the second oil passage **126** and the third oil passage **128** are shaped to be asymmetrical with respect to each other, such that lubricant fed from the first oil passage **124** takes different pressure losses when flowing in the second oil passage **126** and in the third oil passage **128**, and that the flow rates of the lubricant is made deliberately different between the second oil passage **126** and the third oil passage **128**.

As depicted in FIG. **12**, it is conceivable as a third embodiment that the second panel member **120** located at the lowermost layer of the plurality of (two) panel members, i.e. the first panel member **110** and the second panel member **120**, configuring the oil feed member **100** (in the present embodiment, on the lower side of the two panel members, i.e., on the cam cap **50** side) is integrated with the cam cap **50**. Specifically, second panel members **120** are integrated with the cam cap **50** so as to extend frontward from the intake-side recess **54** and the exhaust-side recess **62** of the cam cap **50**, respectively; in this manner, the cam cap **50** and the second panel members **120** are handled as a single member. This configuration facilitates management of components of the cam cap **50** and the second panel members **120** and attachment to the cylinder head **10**.

It is also conceivable as a fourth embodiment, as depicted in FIG. **13**, that four cam caps **50** that are provided to correspond to the four cylinders, respectively, may be integrated with each other. Specifically, the right and left end portions of each cam cap **50** are coupled to each other, such that the four cam caps **50** are integrated with each other and are handled as a single member. This configuration facilitates management of components of the cam caps **50** and attachment to the cylinder head **10**.

It is also conceivable as a fifth embodiment, as depicted in FIG. **14**, that the in-shaft oil passage **42***b* is formed linearly so as to pass the center of the rotation axis of the exhaust-side camshaft **42**. In this case, the other end of the cam journal oil passage **18** communicates with a right end portion of the exhaust-side bearing **14**. This configuration causes end portions of the in-shaft oil passage **42***b* to oppose the cam journal oil passage **18** per 180-degree rotation of the exhaust-side camshaft **42**. This permits lubricant to be fed to the cams **42***a* per 180-degree rotation of the exhaust-side camshaft **42**, i.e. twice during one rotation of the exhaust-side camshaft **42**.

In the fifth embodiment (FIG. **14**), the lubricant inside the in-shaft oil passage **42***b* changes the direction of flow reversely per 180-degree rotation of the exhaust-side camshaft **42**. While the exhaust-side camshaft **42** is rotating at a lower speed, the lubricant inside the in-shaft oil passage **42***b* is fed, changing the direction of flow, into the exhaust-side communicating oil passage **66** per 180-degree rotation of the exhaust-side camshaft **42**. Meanwhile, when the rotation of the exhaust-side camshaft **42** becomes faster, the lubricant inside the in-shaft oil passage **42***b* is unable to smoothly change the direction of flow and thus gets stagnant inside the in-shaft oil passage **42***b*. In other words, in case where the exhaust-side camshaft **42** rotates at a high speed, lubricant is stopped from being fed to the cams **42***a*.

In case, however, where the rotation of the exhaust-side camshaft **42** becomes faster, lubricant that is spattered by movement of other members adheres to the cams **42***a*; thus, lubrication to the cams **42***a* may be skipped. In other words, in case where, as in the fifth embodiment, the exhaust-side camshaft **42** rotates at a high speed, supply of lubricant to the cams **42***a* is stopped, such that excessive (wasteful) supply of lubricant is prevented.

## INDUSTRIAL APPLICABILITY

The present invention is applicable to a lubricant feed mechanism for an engine for feeding lubricant to cams of a valve gear through a cylinder head, a camshaft, and cam caps.

## DESCRIPTION OF REFERENCE SIGNS

**1** Engine
**10** Cylinder head
**30** Valve gear
**40** Intake-side camshaft
**40***a* Cam
**42** Exhaust-side camshaft
**42***a* Cam
**50** Cam cap
**100** Oil feed member
**110** First panel member
**120** Second panel member
**124** First oil passage
**126** Second oil passage
**128** Third oil passage
**140** Bolt

The invention claimed is:

**1**. A lubricant feed mechanism for an engine, configured to feed lubricant to a cam of a valve gear through a cylinder head, a camshaft, and a cam cap, the mechanism comprising:

an oil feed member having an oil passage configured to guide lubricant to be fed through the cam cap to the cam,

the oil feed member including a plurality of panel members laid over each other,

the oil passage in the oil feed member being entirely or partly a groove formed on at least one surface of at least one of the panel members on which the panel members of the oil feed member abut each other.

**2**. The lubricant feed mechanism for an engine according to claim **1**, wherein

the oil feed member is disposed in the cam cap such that an upper end of the oil feed member is set at a lower level than an upper end of the cam cap in a height-wise direction.

**3**. The lubricant feed mechanism for an engine according to claim **2**, wherein

the cam cap has a recess provided around a bolt opening for fixedly attaching the cam cap to the cylinder head, and

the oil feed member has a portion contained within the recess and the oil feed member is fixedly attached to the cylinder head together with the cam cap by a bolt.

**4**. The lubricant feed mechanism for an engine according to claim **2**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed an equal amount of lubricant to the two cams.

**5**. The lubricant feed mechanism for an engine according to claim **2**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed any different amounts of lubricant to the two cams.



**6**. The lubricant feed mechanism for an engine according to claim **2**, wherein

the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member is integrally provided with the cam cap having the oil feed member disposed thereon.

**7**. The lubricant feed mechanism for an engine according to claim **2**, wherein the engine includes a plurality of additional cam caps identical to the cam cap, all of the cam caps being integrally provided with each other.

**8**. The lubricant feed mechanism for an engine according to claim **1**, wherein

the cam cap has a recess provided around a bolt opening for fixedly attaching the cam cap to the cylinder head, and

the oil feed member has a portion contained within the recess and the oil feed member is fixedly attached to the cylinder head together with the cam cap by a bolt.

**9**. The lubricant feed mechanism for an engine according to claim **8**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed an equal amount of lubricant to the two cams.

**10**. The lubricant feed mechanism for an engine according to claim **8**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed any different amounts of lubricant to the two cams.

**11**. The lubricant feed mechanism for an engine according to claim **8**, wherein

the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member is integrally provided with the cam cap having the oil feed member disposed thereon.

**12**. The lubricant feed mechanism for an engine according to claim **8**, wherein the engine includes a plurality of additional cam caps identical to the cam cap, all of the cam caps being integrally provided with each other.

**13**. The lubricant feed mechanism for an engine according to claim **1**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed an equal amount of lubricant to the two cams.

**14**. The lubricant feed mechanism for an engine according to claim **13**, wherein

the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member is integrally provided with the cam cap having the oil feed member disposed thereon.

**15**. The lubricant feed mechanism for an engine according to claim **13**, wherein the engine includes a plurality of additional cam caps identical to the cam cap, all of the cam caps being integrally provided with each other.

**16**. The lubricant feed mechanism for an engine according to claim **1**, wherein

the oil passage in the oil feed member has two branches from an upstream end portion or a middle portion of the oil passage in such a manner as to guide lubricant to two cams, and to feed any different amounts of lubricant to the two cams.

**17**. The lubricant feed mechanism for an engine according to claim **16**, wherein

the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member is integrally provided with the cam cap having the oil feed member disposed thereon.

**18**. The lubricant feed mechanism for an engine according to claim **16**, wherein the engine includes a plurality of additional cam caps identical to the cam cap, all of the cam caps being integrally provided with each other.

**19**. The lubricant feed mechanism for an engine according to claim **1**, wherein

the panel member at the lowermost layer of the plurality of panel members configuring the oil feed member is integrally provided with the cam cap having the oil feed member disposed thereon.

**20**. The lubricant feed mechanism for an engine according to claim **1**, wherein the engine includes a plurality of additional cam caps identical to the cam cap, all of the cam caps being integrally provided with each other.

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